ELSEVIER

CrossMark

The Spine Journal 14 (2014) 1663–1672

THE SPINE JOURNAL

Clinical Study

Reliability and validity of the adapted Dutch version of the revised Scoliosis Research Society 22-item questionnaire

Tom P.C. Schlösser, MD[a], Agnita Stadhouder, MD[b], Janneke J.P. Schimmel, MSc[c], A. Mechteld Lehr, MSc[a], Geert J.M.G. van der Heijden, PhD[d,e], René M. Castelein, MD, PhD[a,*]

[a]*Department of Orthopaedic Surgery, University Medical Center Utrecht, Heidelberglaan 100, 3584 CX, Utrecht, The Netherlands*
[b]*Department of Orthopaedic Surgery, Vrije Universiteit medical center, De Boelelaan 117, 1081 HZ, Amsterdam, The Netherlands*
[c]*Research Department, Sint Maartenskliniek, Hengstdal 3, 6574 NA, Ubbergen, The Netherlands*
[d]*Department Social Dentistry, Academic Center for Dentistry Amsterdam, VU Amsterdam University and University of Amsterdam, Gustav Mahlerlaan 3004, 1081 LA, Amsterdam, The Netherlands*
[e]*Department of Epidemiology, Division Julius Center, University Medical Center Utrecht, Heidelberglaan 100, 3584 CX, Utrecht, The Netherlands*

Received 3 June 2013; revised 27 August 2013; accepted 27 September 2013

Abstract

BACKGROUND CONTEXT: As in other fields of medicine, there is an increasing interest among orthopedic surgeons to measure health-related quality of life in adolescent idiopathic scoliosis patients and to evaluate the burden of disease and the effectiveness of different treatment strategies. The development of the revised Scoliosis Research Society 22-item patient questionnaire (SRS-22r) enabled a comprehensive evaluation of health-related quality of life of these patients. Over the years, the SRS-22r gained wide acceptance and has been used in several different countries, languages, and cultures. The SRS-22r has not been translated into Dutch to date.

PURPOSE: To translate the SRS-22r into Dutch and adapt it cross-culturally as outlined by international guidelines and to test its psychometric properties to measure health-related quality of life of adolescent idiopathic scoliosis patients in the Netherlands.

STUDY DESIGN/SETTING: A cross-sectional, multicenter validation study.

PATIENT SAMPLE: A total of 135 adolescent idiopathic scoliosis patients (mean age 15.1 years old) of three major scoliosis centers in the Netherlands were enrolled in this study. Ninety-two (68%) subjects completed the Dutch SRS-22r, Child Health Questionnaire (CHQ)-CF87 (golden standard for adolescents), and Short Form (SF)-36 (golden standard for adults). Two weeks later, 73 (79%) of 92 respondents returned a second SRS-22r. Demographics, curve type, Risser stage, and treatment status were documented.

OUTCOME MEASURES: Floor and ceiling effects, internal consistency, reproducibility, concurrent validity, and discriminative ability of the Dutch version of the SRS-22r questionnaire.

METHODS: For content analysis, SRS-22r domain scores (function, pain, self-image, mental health, and satisfaction with management) were explored and floor and ceiling effects were determined. Cronbach's α was calculated for internal consistency of each domain of the questionnaires and reproducibility was assessed by test-retest reliability analysis. Using Pearson's correlation coefficient, comparison of the domains of the Dutch SRS-22r with the domains of the SF-36 and Child Health Questionnaire-CF87 assessed the concurrent validity. Differences in SRS-22r domain scores between untreated patients with different curve severity determined the discriminative ability of the questionnaire.

RESULTS: The SRS-22r domains as well as the SF-36 and CHQ-CF87 domains demonstrated no floor effects, but the function, pain, and satisfaction with management domains had ceiling effects,

FDA device/drug status: Not applicable.

Author disclosures: ***TPCS:*** Grant: Alexandre Suerman MD/PhD stipendium (E, Paid directly to institution), Medtronic Research Grant (F, Paid directly to institution). ***AS:*** Nothing to disclose. ***JJPS:*** Nothing to disclose. ***AML:*** Consulting: AOSpine International (B, Paid directly to institution). ***GJMGvdH:*** Nothing to disclose. ***RMC:*** Grant: Alexandre Suerman MD/PhD stipendium (E, Paid directly to institution), Medtronic Research Grant (F, Paid directly to institution); Speaking/Teaching Arrangements: Medtronic Speakers Bureau (B, Paid directly to institution).

The disclosure key can be found on the Table of Contents and at www.TheSpineJournalOnline.com.

Supported by the Alexandre Suerman MD/PhD program, a Medtronic research grant, and by the Anna Foundation/NOREF.

* Corresponding author. Department of Orthopaedic Surgery, G05.228, University Medical Center Utrecht, P.O. Box 85500, 3508 GA Utrecht, The Netherlands. Tel.: (31) 88-75-583-27.

E-mail address: R.M.Castelein@umcutrecht.nl (R.M. Castelein)

http://dx.doi.org/10.1016/j.spinee.2013.09.046

indicating the proportion of subjects with the maximum score between 19.6% and 33.0%. Internal consistency was very satisfactory for all SRS-22r domains: Cronbach's α was between 0.718 and 0.852. By omitting question 15, the internal consistency of the function domain increased from 0.746 to 0.827. Test-retest reliability was ≥0.799 for all SRS-22r domains. The function, pain, mental health, and self-image domains correlated under the 0.001 significance level with the corresponding CHQ-CF87 and SF-36 domains. The satisfaction with management domain did not correlate with the other questionnaires. The SRS-22r had the ability to detect differences between groups with different curve severity; patients with a severe scoliotic curvature had significantly lower pain and self-image domain scores than patients with relatively mild scoliosis.

CONCLUSIONS: The Dutch SRS-22r had the properties needed for the measurement of patient perceived health-related quality of life of adolescent idiopathic scoliosis patients in the Netherlands. The Dutch SRS-22r could be used for the longitudinal follow-up of adolescent idiopathic scoliosis patients from adolescence to adulthood and for establishing the effects of conservative or invasive surgical treatment.

Keywords: Scoliosis Research Society 22 revised questionnaire; Health-related quality of life; Adolescent idiopathic scoliosis; Cross-cultural adaptation; Content analysis; Reliability; Concurrent validity; Discriminantive ability

Introduction

Adolescent idiopathic scoliosis (AIS) is a deformity of the spine and trunk in previously healthy children of unknown etiology [1]. As a consequence of the deformity, especially immature children with progressive curves could suffer from severe physical symptoms (back pain, diminished back mobility, and decreased lung function) and psychosocial symptoms (body image issues and diminished self-esteem) [2,3]. Even without severe progression, when the curves are usually not life-threatening and no brace or surgical treatment is used, the deformity may interfere with daily life and might have significant effects on health-related quality of life. Although the most common scoliosis treatments, bracing and surgery, aim to prevent progression of the spinal curvature and to improve symptoms, evaluations of effectiveness are in many instances mainly based on radiographic measurements of the curvature [4,5]. The effectiveness in terms of health-related quality of life, however, is probably more important and often remain relatively underexposed.

The development of the Scoliosis Research Society (SRS) patient questionnaire enabled a comprehensive evaluation of the health-related quality of life of AIS patients. The original SRS 24-item questionnaire, a simple, practical, and discriminative disease-specific questionnaire as developed by Haher et al. aimed to facilitate the assessment of clinical outcome after AIS treatment. This questionnaire consisted of 24 questions and measured four domains: pain, self-image, function, and satisfaction with management [6]. Because of a number of concerns and shortcomings regarding its psychometric properties, a series of modifications and refinements led, through the SRS 23-item questionnaire, to the development of the SRS 22-item questionnaire (SRS-22) in 2000. The function, pain, self-image, and mental health domains consisted of five questions and the satisfaction with management domain consisted of two [7]. In 2005, Asher et al. improved internal consistency by a minor revision of question 18, resulting in the current revised SRS 22-item questionnaire (SRS-22r) [8]. Over the years, the SRS-22 and SRS-22r in particular have gained wide acceptance; they were translated and adapted into 17 languages and/or cultures [9–26]. The SRS-22 was previously translated into Dutch and adapted cross-culturally to the Netherlands by Bunge et al., but the psychometric properties were never completely investigated [27]. To date, the SRS-22r has not been translated into Dutch, but there is a great need from both a clinical and research perspective for it. The aims of this study are to translate the original SRS-22r into Dutch, to adapt it to the Dutch culture, and to test its properties for evaluation of health-related quality of life of AIS patients in the Netherlands.

Methods

Guidelines for cross-cultural adaptation and validation of self-reported health status measures as outlined by Beaton et al. were used for this study [28].

Cross-cultural adaptation and translation process

The translation process consisted of four stages, followed by pretesting and final validity and reliability analysis. First, an orthopedic researcher (MD), informed for the study procedure, and uninformed technical student translated the original English SRS-22r into Dutch [8]. The translators used Dutch as their mother tongue and translated independently of each other. Second, the translators and a recording observer merged the two translations and the Dutch version of the SRS-22 questionnaire [27]. For any discrepancy, consensus was reached by discussion. Third, two independent, uninformed bilingual translators who used English as their mother tongue (resident general surgery and technical doctoral student) performed a translation back from Dutch into English. They were blinded to the original SRS-22r questionnaire to avoid information bias. Fourth, during an expert committee meeting, the translators, back-translators, a professor of spinal surgery, a recording observer, an experienced

epidemiologist, and a professional translator (English-Dutch and Dutch-English) reviewed all translations and written reports of the different stages as well as the original questionnaire. Equivalence of the prefinal version and original English SRS-22r was examined for semantics, idioms, and conceptual meaning. The expert committee discussed the translations and adaptations and developed a prefinal version of the Dutch SRS-22r.

Prefinal testing

Thirty-one consecutive Dutch-speaking AIS patients between 10 and 18 years old (23 girls, eight boys) completed the prefinal version of the Dutch SRS-22r in the outpatient clinic of a tertiary spine center (Wilhelmina Children's Hospital, University Medical Center Utrecht, Utrecht, The Netherlands). Before the prefinal testing and final testing, approval of the institutional review board and Medical Ethics Committee of the University Medical Center Utrecht was received. The patients were interviewed about their understanding of the questions and answers and about the difficulties they had encountered. In addition, the duration of completion of the questionnaire assessed the feasibility of administering the test to regular patients. Because the total number of prefinal questionnaires was small, statistical tests were not performed. On the basis of the subjects' comments, the expert committee determined the final version of the questionnaire to be tested.

Study procedures

A total of 135 patients with a history of AIS were asked to participate in this validation study; each subject and his or her parents gave informed consent. The final testing was carried out in the outpatient clinic of three major spine centers in The Netherlands (Wilhelmina Children's Hospital, University Medical Center Utrecht, Utrecht; Vrije Universteit Medisch Centrum, Amsterdam; and the Sint Maartenskliniek, Nijmegen) over a 2-month period. All AIS patients older than age 10 years who had the ability to speak and read Dutch fluently were included. Patients with congenital anomalies, central or peripheral neurological symptoms, or systemic disorders (chronic kidney or liver diseases, tumors, rheumatoid-like diseases, or mental/psychiatric disorders) were excluded. On the most recent radiograph of the spine, a trained orthopedic researcher classified the curve type of the deformities, determined Risser stage, and measured the Cobb angles [29–31]. At the outpatient clinic, all participants received the final Dutch SRS-22r, a visual analog scale for pain (VAS; 100 mm, score 0 to 100), and previously validated Dutch versions of RAND 36-item Short Form Health Survey (SF-36) and the Child Health Questionnaire–Child Form 87 (CHQ-CF87; HealthActCHQ Inc., Cambridge, MA, USA) [32,33]. For the comparability with the other questionnaires in this study, the VAS score was inverted: the maximum score (100) corresponded to no pain and the minimum score (0) to severe pain. The subjects were instructed to complete the questionnaires at home by themselves without their parents giving them help and return the forms within a week. The SF-36 and CHQ-CF87 are previously validated, generic health-related quality-of-life questionnaires for adults (>18 years old) and adolescents (10 to 18 years old), respectively. To test the test-retest reliability, 2 weeks later, a second final Dutch SRS-22r and a request to return the questionnaire were mailed to all participants. If participants returned the first SRS-22r questionnaire after they received the second SRS-22r, the participants response was not included in the test-retest reliability analysis. The first SRS-22r of these participants, however, was used for other reliability and validity analyses in this study.

Statistical analysis of data

Content analysis

Scoring of the questions and domains of the SRS-22r, SF-36, and CHQ-CF87 was performed according to the corresponding scoring guidelines [33,34]. Scoring of the SRS domains was equal to the original SRS-22r scoring system: total scores were between 5 and 25 for the domains function, pain, self-image and mental health (each based on five questions) and between 2 and 10 for satisfaction with management (based on two questions); the average scores varied between 1 (minimum score) and 5 (maximum score) for all domains. For content analysis, data were explored (mean, standard deviation, and range) and checked for outliers. In addition, floor and ceiling effects (>10% with minimum or maximum possible score, respectively) were calculated.

Reliability

Cronbach's α assessed the internal consistency of each SRS-22r, SF-36, and CHQ-CF87 domain and was checked for variation if a question was omitted. Cronbach's $\alpha<0.70$ indicated poor internal consistency, between 0.70 and 0.80 was good internal consistency, and >0.80 was excellent internal consistency. Reproducibility of each SRS-22r domain score was assessed by test-retest reliability analysis of the first and second SRS-22r using the intraclass correlation coefficient (ICC). ICC scores between 0.70 and 0.80 indicated good and >0.80 indicated excellent reliability.

Concurrent validity

For the study of concurrent validity, the mean scores of each domain of the Dutch SRS-22r were compared with the domains of the SF-36, CHQ-CF87, and VAS for pain. Poor, good, and excellent concurrent validity was defined as a Pearson's correlation coefficient less than 0.50, between 0.50 and 0.70, and more than 0.70, respectively.

Discriminantive ability

Two subsets of patients with different clinical variables who had no treatment for their curve to date were determined before starting the discriminant ability analysis.

The first group comprised patients with a mild curve (Cobb angle <30°), who are normally asymptomatic. The second group consisted of patients with a moderate or severe curve (Cobb angle >30°). Patients with a history of brace therapy or scoliosis surgery were excluded in the discriminative ability analysis. The ability of the questionnaire to detect differences between those two groups was tested. The three participating centers had a joint guideline for treatment of idiopathic scoliosis when this study was performed.

Statistical analyses were performed using SPSS 20.0 for Windows (SPSS Inc., Chicago, IL, USA). Cronbach's α, ICC (two-way random model with absolute agreement), and Pearson's correlation coefficient r were used to asses internal consistency, reproducibility and concurrent validity of the Dutch translation of the SRS-22r questionnaire, respectively. If $p<.001$, the correlation with generic CHQ-CF87 and SF-36 questionnaires was statistically significant. Independent sample Student *t* tests (significance level 0.05) were used to evaluate differences in SRS-22r domain scores between the two subgroups of untreated subjects.

Results

Prefinal testing

At prefinal testing, the majority of the patients understood the questions and answers completely, responded to all questions, and completed the questionnaire within 10 minutes. However, the expert committee adapted four questions (9, 16, 21, and 22) with minor changes because of difficulties that were encountered during the interviews. Because of the limited mathematical level and vocabulary of 10- and 11-year-old AIS patients, the answers in percentages of question 9 were replaced by a commonly used ordinal scale for ability/disability, and in question 16 the Dutch phrasing of ''down-hearted and blue'' was replaced by an easier word. To allow for examination of AIS patients who were under observation, ''treatment'' in question 21 and ''management'' in question 22 were changed into ''regular check-ups and treatment.'' Other comments did not require adjustments. The final Dutch SRS-22r questionnaire can be found in the Supplementary Appendix or on the SRS website [34].

Patient sample

Ninety-two (68%) AIS patients completed the first set of questionnaires (Table 1). Seventy-three (79%) of them completed both sets of questionnaires. The average response time between the first and second set of questionnaires was 19.3 (±8.2) days. Table 1 shows the basic clinical characteristics of the respondents. The mean age was 15.1 (±2.0, range 10–21) years, and 80 (87%) participants were female. Curve severity ranged between a 10° and 70° Cobb angle (mean 38°±14°, median 38°). Fifty-one respondents had a thoracic curve (Lenke I and II), 16 a (thoraco)lumbar curve (Lenke V), and 25 a thoracic and lumbar structural deformity (Lenke III, IV, or VI) [29]. Fifty-three respondents were under observation (Cobb < 30°, N=15; Cobb >30°, N=38), 20 under brace treatment, and 19 had undergone operative scoliosis correction (median time since surgery 9 months, range 1–82 months). No significant differences in gender and curve type distribution were observed between the different cohorts.

Table 1
Clinical characteristics of the study population are shown

Clinical characteristics	AIS patients (N=92)
Women (%)	80 (87)
Postmenarchal (%)	62 (67)
Age (±SD)	15.1 (±2.0)
BMI (±SD)	19.6 (±2.8)
Cobb angle (±SD)	38° (±14)
Curve type	
Thoracic curve (%)	51 (55)
Thoracic and (thoraco)lumbar curve (%)	25 (27)
(Thoraco)lumbar curve (%)	16 (17)
Risser stage	
I (%)	11 (12)
II (%)	14 (15)
III (%)	9 (10)
IV (%)	33 (36)
V (%)	23 (25)
Treatment	
Under observation (%)	53 (58)
Bracing (%)	20 (22)
Surgery (%)	19 (21)
Posterior spondylodesis (%)	17 (18)
Anterior spondylodesis (%)	2 (2)
Time since surgery in months (±SD)	18 (±21)

AIS, adolescent idiopathic scoliosis; BMI, body mass index; SD, standard deviation.

Content analysis

In our study population of 92 AIS patients, the mean domain scores of the final Dutch SRS-22r were between 3.81 and 4.49 (Table 2). The SRS-22r domains as well as the SF-36 and CHQ-CF87 domains demonstrated no floor effects. Ceiling effects between 19.6% and 33.0% were observed for the function, pain and satisfaction with management domains of the SRS-22r. The function domain of the SRS-22r demonstrated a ceiling effect (33%) comparable to the physical function domain of the SF-36 (27%) and CHQ-CF87 (38%), indicating the proportion of subjects with the maximum score. Similarly, the pain domain of the SRS-22r demonstrated a lower ceiling effect (20%) than the bodily pain domain of the SF-36 (23%), CHQ-CF87 (25%), and the VAS for pain (22%). No ceiling effects were observed for the self-image and mental health domains of the Dutch SRS-22r, whereas the corresponding SF-36 and CHQ-CF87 domains showed relatively high ceiling effects (up to 84%).

Reliability

The statistical analysis showed good results for internal consistency of the SRS-22r domains function, self-image,

Table 2
Descriptive statistics are shown for the SRS-22r, SF-36, VAS for pain, and CHQ-CF87 questionnaires

Domains	Mean score	SD	Range	% With floor effect*	% With ceiling effect*
SRS-22r					
Function	4.5	0.5	3.2–5.0	0	33
Pain	4.0	0.9	1.0–5.0	1	20
Self-image	3.8	0.7	2.0–5.0	0	4
Mental health	4.1	0.6	2.2–5.0	0	8
Satisfaction with management	4.0	0.8	1.5–5.0	0	22
SF-36					
Physical function	85	16	25–100	0	27
Role: physical	78	32	0–100	4	62
Bodily pain	77	20	10–100	0	23
General health	74	21	15–100	0	15
Vitality	71	19	0–100	1	13
Social functioning	88	17	25–100	0	52
Role: emotional	90	26	0–100	4	83
Mental health	82	14	40–100	0	15
VAS for pain†,‡	72	75	10–100	0	22
CHQ-CF87					
Behavior	85	10	58–100	0	3
Bodily pain	68	27	0–100	1	25
Family activity	91	10	60–100	0	42
Mental health	79	13	42–100	0	4
General health	72	18	25–100	0	5
Role: function behavior	96	10	44–100	0	84
Physical function	90	14	18–100	0	38
Role: emotional	91	18	11–100	0	70
Role: physical	93	15	33–100	0	73
Self-esteem	76	12	46–100	0	3
Global behavior‡	80	17	30–100	0	24
Global general health‡	76	21	30–100	0	23
Family cohesion‡	81	19	0–100	1	33
Change in health‡	3.0	1.0	1.0–5.0	5	11

CHQ, Child Health Questionnaire; SF, Short Form; SRS, Scoliosis Research Society; SD, standard deviation; VAS, visual analog scale.

* The floor and ceiling effects are the percentage of subjects that answered the lowest or highest possible score of the questionnaire, respectively: SRS-22r, lowest and highest possible score was 1.0 and 5.0; SF-36, VAS for pain; and CHQ-CF87, lowest and highest possible score was 0.0 and 100.0.

† The maximum score '100' corresponded to no pain and the minimum score '0' corresponded to severe pain.

‡ Single item.

mental health and satisfaction with management, and excellent internal consistency for the domain pain (Table 3). If question 15 was omitted, because of a negative correlation with the function domain score, Cronbach's α increased to 0.827. The SF-36 domain social functioning had poor, physical function and mental health excellent, and all other domains good internal consistency. The internal consistency was excellent for all CHQ-CF87 domains (Cronbach's α between 0.829 and 0.933), except for domain family activity (Cronbach's α=0.689). The reproducibility of the satisfaction with management domain was good, whereas the domains function, pain, self-image, and mental health demonstrated excellent test-retest results (ICC per domain: function 0.861; pain 0.929; self-image 0.878; mental health 0.855; satisfaction with management 0.799).

Concurrent validity

All correlations between the SRS-22r and SF-36 domain scores were lower than the <0.001 significance level and differed between 0.390 and 0.833 (Table 4). The SRS-22r function domain had excellent correlation with the SF-36 domains physical function (r=0.808) and role-physical (r=0.717), and with the CHQ-CF87 domain physical function (r=0.708). The SRS-22r domain pain demonstrated excellent correlation with the SF-36 domains bodily pain (r=0.857) and physical function (r=0.833), with the CHQ-CF87 domain bodily pain (r=0.886) and with the VAS score for pain (r=0.872). The average mental health score of the SF-36 correlated excellent with the mental health score of the SRS-22r (r=0.787). The SRS-22r domain self-image had good correlation with the CHQ-CF87 general health score. No correlations were observed for the SRS-22r domain satisfaction with management.

Discriminative ability

Statistical analysis revealed that participants who were under observation for a mild curve had significantly higher scores in all SRS-22r domains than participants with moderate or severe scoliosis (function p=.002, pain p=.003, self-image p=.004, mental health p=.019, and satisfaction with

Table 3
Internal consistency of the SRS-22r, SF-36, and CHQ-CF87 domains consisting of more than one item is shown

SRS-22r domain	Cronbach's α	SF-36 domain	Cronbach's α	CHQ-CF87 domain	Cronbach's α
Function	0.746*	Physical function	0.846	Behavior	0.827
Pain	0.852	Role: physical	0.784	Bodily pain	0.933
Self-image	0.718	Bodily pain	0.792	Family activity	0.689
Mental health	0.777	General health	0.798	Mental health	0.908
Satisfaction with management	0.712	Vitality	0.757	General health	0.829
		Social functioning	0.635	Role: function behavior	0.857
		Role: emotional	0.795	Physical function	0.860
		Mental health	0.816	Role: emotional	0.900
				Role: physical	0.906
				Self-esteem	0.884

CHQ, Child Health Questionnaire; SF, Short Form; SRS, Scoliosis Research Society.
* If question 15 is omitted, Cronbach's α is 0.827.

management p=.015) (Table 5; Figure), indicating the ability of the questionnaire to discriminate between scoliosis patients with different levels of disease-specific quality of life.

Discussion

The present study describes the cross-cultural translation and adaptation of the original SRS-22r into Dutch following the international guidelines, and the evaluation of its psychometric properties [28,35]. The Dutch SRS-22r had very satisfactory reliability, correlated well with generic questionnaires and was useful for the purpose to measure cross-sectional differences between patients with different clinical status. The SRS-22 and SRS-22r versions are widely accepted instruments for the measurement of health-related quality of life in scoliosis patients and were

Table 4
Concurrent validity was calculated for the SRS-22r domains in relation to the SF-36 domains, CHQ-CF87 domains, and VAS score for pain

SRS-22r domain	SF-36 domain	r†	CHQ-CF87 domain	r†	VAS	r†
Function	Physical function	0.808	Physical function	0.708	VAS for pain*	0.473
	Role: physical	0.717	Bodily pain	0.606		
	Bodily pain	0.699	Role: physical	0.570		
	Social functioning	0.502	Family cohesion*	0.520		
	General health	0.424	Self-esteem	0.397		
	Vitality	0.465	General health	0.386		
			Global general health*	0.382		
			Mental health	0.366		
Pain	Bodily pain	0.857	Bodily pain	0.886	VAS for pain*	0.872
	Physical function	0.833	Physical function	0.698		
	Role: physical	0.694	Role: physical	0.578		
	Vitality	0.431	Change in health*	0.463		
	General health	0.396	General health	0.441		
	Social functioning	0.390	Global general health*	0.387		
Self-image	Bodily pain	0.493	General health	0.515	VAS for pain*	0.448
	Physical function	0.434	Change in health*	0.477		
	General health	0.396	Bodily pain	0.462		
			Self-esteem	0.415		
			Global general health*	0.415		
			Physical function	0.374		
Mental health	Mental health	0.787	Mental health	0.623	VAS for pain*	0.395
	Vitality	0.648	Self-esteem	0.538		
	Social functioning	0.592	Family activity	0.502		
	Role: physical	0.522	Global general health*	0.499		
	Physical function	0.501	General health	0.486		
	Bodily pain	0.492	Role: emotional	0.476		
	Role: emotional	0.489	Physical function	0.434		
	General health	0.452	Behavior	0.413		
			Bodily pain	0.413		
Satisfaction with management	No correlations		No correlations		No correlations	

CHQ, Child Health Questionnaire; r, Pearson's correlation coefficient; SF, Short Form; SRS, Scoliosis Research Society; VAS, visual analog score.
All statistically significant correlations are shown, ranked by degree of correlation.
* Single item.
† Correlations are significant at the <.001 level.

Table 5
Cross-sectional differences are shown for two subgroups of idiopathic scoliosis patients that were under observation

SRS-22r domain	SRS-22r domain	Mean	SD	% Floor effect	% Ceiling effect
Under observation, Cobb <30° (n=15)	Function	4.8	0.3	0	53.3
	Pain	4.6	0.5	0	46.7
	Self-image	4.2	0.5	0	13.3
	Mental health	4.4	0.4	0	13.3
	Satisfaction with management	4.2	0.6	0	26.7
Under observation, Cobb >30° (n=38)	Function	4.5	0.5	0	42.1
	Pain	3.8	1.0	0	21.1
	Self-image	3.6	0.7	0	2.6
	Mental health	4.0	0.6	0	7.9
	Satisfaction with management	3.7	0.7	0	5.3

CHQ, Child Health Questionnaire; r, Pearson's correlation coefficient; SF, Short Form; SRS, Scoliosis Research Society.

previously adapted successfully for the Brazilian [9], Chinese [10–12], French-Canadian [13], German [14], Greek [15], Italian [16], Japanese [17], Korean [18], Norwegian [19], Persian [20], Polish [21], Swedish [22], Spanish [23,24], Thai [25], and Turkish [26] language and culture. Whether this cross-sectional study provides supportive evidence that the Dutch SRS-22r is a reliable and valid instrument for evaluation of AIS patients undergoing conservative or surgical interventions—in a longitudinal setup—will be discussed [36].

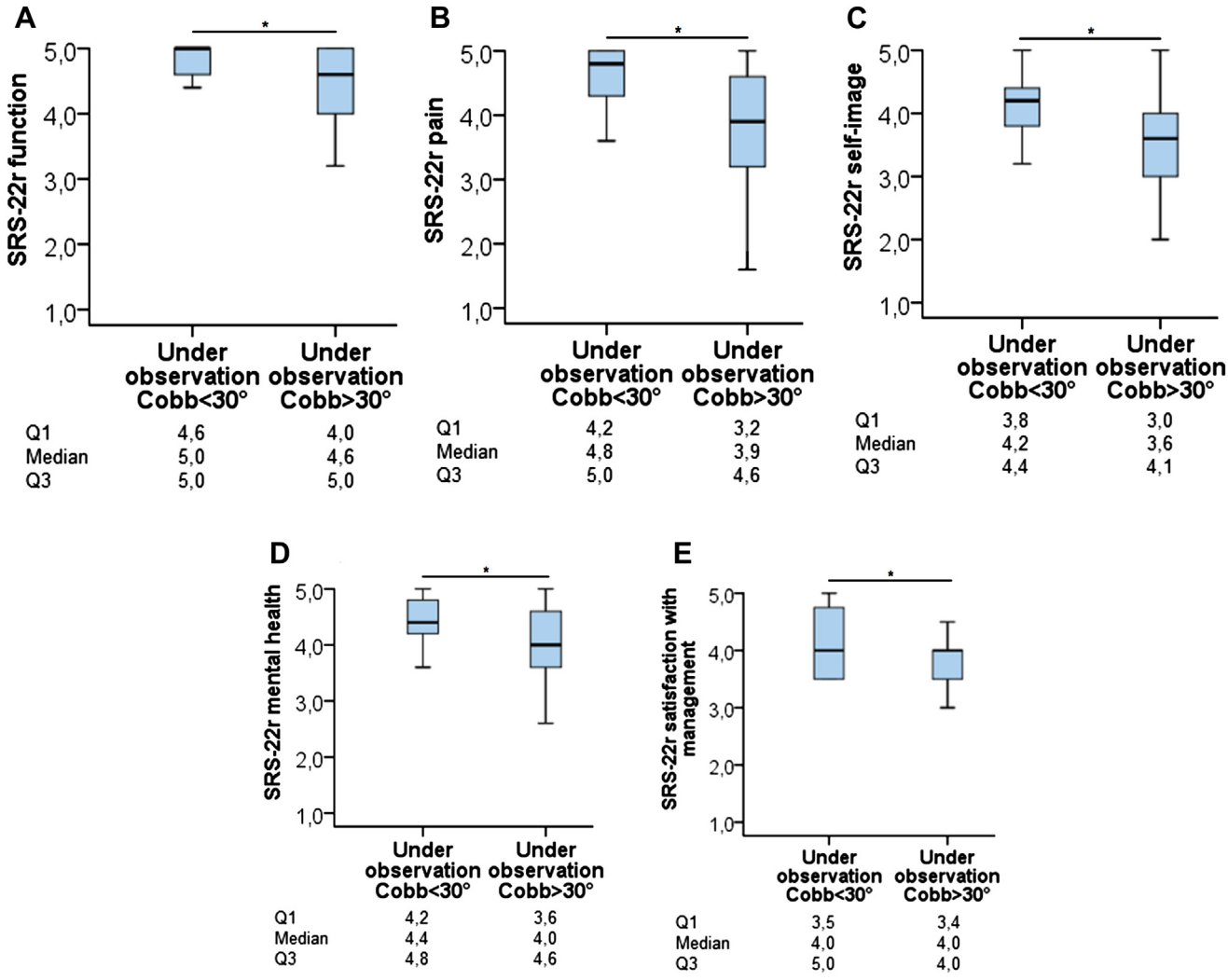

Figure. (A–E) Box-whisker plots for the SRS-22r domain scores are presented for two subsets of patients with different curve severities that were under observation. * Differences under the significance level.

For the long-term follow-up of AIS patients, it is obvious that an instrument is needed that can be used from adolescence to adulthood. The Dutch SRS-22r correlated well with the corresponding domains of the most widely used generic health-related quality of life questionnaires for adolescents (CHQ-CF87) and for adults (SF-36). These generic questionnaires are in themselves less useful for the follow-up of AIS patients because the SF-36 is not validated for adolescents and the CHQ-CF87 is not validated for adults [32,33,37]. This is the first complete cross-cultural adaptation and validation study comparing the results of the SRS-22r with a generic questionnaire that was developed for adolescents and with another generic questionnaire for adults. A majority of the researchers of the validation studies of the SRS-22r in different countries and cultures compared their questionnaire with the SF-36 for adults [9–12,15–18,20,22,25,26]. In this study, the SRS-22r domains were compared with the CHQ-CF87 and SF-36 domains; the correlations of the corresponding domains were very acceptable and the results were similar to the studies of Glattes et al. and Asher et al. [8,38]. Because of the validity of the questionnaire in adolescents and adults, the Dutch SRS-22r has the properties for follow-up of health-related quality of life of AIS patients, irrespective of age, which is lacking for the CHQ-CF87 and SF-36.

In this study, the ability to detect minimal clinically important differences and responsiveness of the Dutch SRS-22r has not been investigated completely, because longitudinal data are required for adequate calculations. Our results are encouraging, however, that the questionnaire is capable of discriminating between AIS patients with different curve severities. As an estimation for clinical important difference, the variability of the function, pain, self-image, mental health, and satisfaction with management domains can be used: 0.71, 1.19, 0.88, 0.83, and 0.71, respectively. In future studies, the responsiveness can be obtained by the examination of the mean change as a result of the intervention divided by the variability and can be used for sample size calculations [36].

The Dutch SRS-22r was able to address physical and psychosocial symptoms that AIS patients could encounter in daily life as indicated by low floor effects [8]. However, ceiling effects were observed in some domains, which might be due to our young population (mean age 15.1, minimum age 10 years) with relatively mild curves (lowest Cobb angle 10°). In a longitudinal study, however, with AIS patients requiring treatment, ceiling effects might be reduced because this study showed lower ceiling effects for AIS patients with more severe curves, similar to the Polish and Thai validation studies [21,25].

The contribution of each question to the relevant SRS-22r domain score and the repeatability was tested and was optimized to ensure reliability of the Dutch SRS-22r. Previously, discussion of the internal consistency of the function domain of the SRS-22 led to the development of the SRS-22r [39–44]. The problem was traced to questions 15 and 18 [12,23,24,26,39–44]. In this study, the internal consistency of the function domain was already satisfactory, but the reliability of the score increased when question 15 (“Are you and/or your family experiencing financial difficulties because of your back?”) was omitted. One of the reasons that question 15 is not in line with the other questions of the function domain might be some sort of perception bias resulting from the suboptimal ability of adolescent schoolchildren to judge their families’ financial situations. Other validation studies that encountered problems with the reliability of question 15, as well as this study, included predominantly young adolescent scoliosis patients and no or a few adults [12,23,24,26]. On the one hand, the internal consistency is slightly higher if question 15 is omitted. On the other hand, for overtime measurements from childhood to adulthood and for better comparability with many other versions around the world (in which question 15 is included in the scoring), it might be better to include question 15 in the scoring of the Dutch SRS-22r’s function domain. As an addition to the ongoing discussing about the contribution of questions 15 and 18 to the function domain, an item response theory model could help in determining the value of each question and further refinement of the SRS-22r questionnaire. This model could take into account that not all questions are equally difficult and might correlate with multiple domains, but a sample size of more than 100 respondents is required [45].

Conclusion

The Dutch SRS-22r has the properties needed for measurement of health-related quality of life of AIS patients in the Netherlands. Considering that this is a cross-sectional study, the SRS-22r could be used for the longitudinal follow-up of AIS patients after conservative or invasive surgical treatment. For future research aiming at clinical outcome after treatment of AIS, we recommend implementing the Dutch SRS-22r because it could be of clinical importance. Although radiographic measures can provide a physician detailed information about the three-dimensional morphology of the spine, self-reported, health-related quality-of-life measures can provide information about the well-being and performance of the patients in daily life.

Acknowledgment

The authors thank Dr J. Fouche, Mr J. Doppenberg, and Ms C. van Weelden for their help during the translation work and Ms T. Snippert for the distribution of the questionnaires in the Sint Maartenskliniek, Nijmegen.

Appendix

Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.spinee.2013.09.046.

References

[1] Kouwenhoven JW, Castelein RM. The pathogenesis of adolescent idiopathic scoliosis: review of the literature. Spine 2008;33: 2898–908.

[2] Collis DK, Ponseti IV. Long-term follow-up of patients with idiopathic scoliosis not treated surgically. J Bone Joint Surg Am 1969;51: 425–45.

[3] Payne WK 3rd, Ogilvie JW, Resnick MD, et al. Does scoliosis have a psychological impact and does gender make a difference? Spine 1997;22:1380–4.

[4] Rowe DE, Bernstein SM, Riddick MF, et al. A meta-analysis of the efficacy of non-operative treatments for idiopathic scoliosis. J Bone Joint Surg Am 1997;79:664–74.

[5] Weinstein SL, Dolan LA, Cheng JC, et al. Adolescent idiopathic scoliosis. Lancet 2008;371:1527–37.

[6] Haher TR, Gorup JM, Shin TM, et al. Results of the scoliosis research society instrument for evaluation of surgical outcome in adolescent idiopathic scoliosis. A multicenter study of 244 patients. Spine 1999;24:1435–40.

[7] Asher MA, Min Lai S, Burton DC. Further development and validation of the scoliosis research society (SRS) outcomes instrument. Spine 2000;25:2381–6.

[8] Asher MA, Lai SM, Glattes RC, et al. Refinement of the SRS-22 health-related quality of life questionnaire function domain. Spine 2006;31:593–7.

[9] Rosanova GC, Gabriel BS, Camarini PM, et al. Concurrent validity of the brazilian version of SRS-22r with br-SF-36. Rev Bras Fisioter 2010;14:121–6.

[10] Cheung KM, Senkoylu A, Alanay A, et al. Reliability and concurrent validity of the adapted chinese version of scoliosis research society-22 (SRS-22) questionnaire. Spine 2007;32:1141–5.

[11] Li M, Wang CF, Gu SX, et al. Adapted simplified Chinese (mainland) version of scoliosis research society-22 questionnaire. Spine 2009;34: 1321–4.

[12] Qiu G, Qiu Y, Zhu Z, et al. Re-evaluation of reliability and validity of simplified chinese version of SRS-22 patient questionnaire: a multicenter study of 333 cases. Spine 2011;36:E545–50.

[13] Beausejour M, Joncas J, Goulet L, et al. Reliability and validity of adapted french Canadian version of scoliosis research society outcomes questionnaire (SRS-22) in Quebec. Spine 2009;34: 623–8.

[14] Niemeyer T, Schubert C, Halm HF, et al. Validity and reliability of an adapted German version of scoliosis research society-22 questionnaire. Spine 2009;34:818–21.

[15] Antonarakos PD, Katranitsa L, Angelis L, et al. Reliability and validity of the adapted Greek version of scoliosis research society - 22 (SRS-22) questionnaire. Scoliosis 2009;4:14.

[16] Monticone M, Baiardi P, Calabro D, et al. Development of the Italian version of the revised scoliosis research society-22 patient questionnaire, SRS-22r-I: cross-cultural adaptation, factor analysis, reliability, and validity. Spine 2010;35:E1412–7.

[17] Hashimoto H, Sase T, Arai Y, et al. Validation of a Japanese version of the Scoliosis Research Society-22 patient questionnaire among idiopathic scoliosis patients in Japan. Spine 2007;32: E141–6.

[18] Lee JS, Lee DH, Suh KT, et al. Validation of the Korean version of the Scoliosis Research Society-22 questionnaire. Eur Spine J 2011; 20:1751–6.

[19] Adobor RD, Rimeslatten S, Keller A, Brox JI. Repeatability, reliability, and concurrent validity of the Scoliosis Research Society-22 questionnaire and EuroQol in patients with adolescent idiopathic scoliosis. Spine 2010;35:206–9.

[20] Mousavi SJ, Mobini B, Mehdian H, et al. Reliability and validity of the Persian version of the Scoliosis Research Society-22r questionnaire. Spine 2010;35:784–9.

[21] Glowacki M, Misterska E, Laurentowska M, Mankowski P. Polish adaptation of Scoliosis Research Society-22 questionnaire. Spine 2009;34: 1060–5.

[22] Danielsson AJ, Hasserius R, Ohlin A, Nachemson AL. Health-related quality of life in untreated versus brace-treated patients with adolescent idiopathic scoliosis: a long-term follow-up. Spine 2010;35:199–205.

[23] Bago J, Climent JM, Ey A, et al. Re: Asher MA, Lai SM, Glattes RC, et al. Refinement of the SRS-22 questionnaire function domain. Spine 2006;31:593–7. Spine 2006;31:1758.

[24] Climent JM, Bago J, Ey A, et al. Validity of the Spanish version of the Scoliosis Research Society-22 (SRS-22) patient questionnaire. Spine 2005;30:705–9.

[25] Sathira-Angkura V, Pithankuakul K, Sakulpipatana S, et al. Validity and reliability of an adapted thia version of Scoliosis Research Society-22 questionnaire for adolescent idiopathic scoliosis. Spine 2012;37:783–7.

[26] Alanay A, Cil A, Berk H, et al. Reliability and validity of adapted Turkish version of Scoliosis Research Society-22 (SRS-22) questionnaire. Spine 2005;30:2464–8.

[27] Bunge EM, Juttmann RE, de Kleuver M, et al. NESCIO group. Health-related quality of life in patients with adolescent idiopathic scoliosis after treatment: short-term effects after brace or surgical treatment. Eur Spine J 2007;16:83–9.

[28] Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of cross-cultural adaptation of self-report measures. Spine 2000;25:3186–91.

[29] Lenke LG, Betz RR, Harms J, et al. Adolescent idiopathic scoliosis: a new classification to determine extent of spinal arthrodesis. J Bone Joint Surg Am 2001;83-A:1169–81.

[30] Cobb JR. Outline for the study of scoliosis, the American Academy of Orthopaedic Surgeons (2nd ed), Instructional Course Lectures 1948;5:261.

[31] Risser JC. The iliac apophysis; an invaluable sign in the management of scoliosis. Clin Orthop 1958;11:111–9.

[32] Raat H, Landgraf JM, Bonsel GJ, et al. Reliability and validity of the child health questionnaire-child form (CHQ-CF87) in a dutch adolescent population. Qual Life Res 2002;11:575–81.

[33] van der Zee KI, Sanderman R. Het meten van de algemene gezondheidstoestand met de RAND-36, een handleiding. Groningen: Rijksuniversiteit Groningen, Noordelijk Centrum voor Gezondheidsvraagstukken, 1992.

[34] Scoliosis Research Society outcomes. 2013. Available from: http://www.srs.org/professionals/SRS_outcomes/.

[35] Guillemin F, Bombardier C, Beaton D. Cross-cultural adaptation of health-related quality of life measures: literature review and proposed guidelines. J Clin Epidemiol 1993;46:1417–32.

[36] Guyatt G, Walter S, Norman G. Measuring change over time: assessing the usefulness of evaluative instruments. J Chronic Dis 1987;40:171–8.

[37] Aaronson NK, Muller M, Cohen PD, et al. Translation, validation, and norming of the Dutch language version of the SF-36 health survey in community and chronic disease populations. J Clin Epidemiol 1998;51:1055–68.

[38] Glattes RC, Burton DC, Lai SM, et al. The reliability and concurrent validity of the Scoliosis Research Society-22r patient questionnaire compared with the child health questionnaire-CF87 patient questionnaire for adolescent spinal deformity. Spine 2007;32:1778–84.

[39] Asher M, Min Lai S, Burton D, Manna B. Discrimination validity of the Scoliosis Research Society-22 patient questionnaire: relationship to idiopathic scoliosis curve pattern and curve size. Spine 2003;28:74–8.

[40] Asher M, Min Lai S, Burton D, Manna B. Scoliosis Research Society-22 patient questionnaire: responsiveness to change associated with surgical treatment. Spine 2003;28:70–3.

[41] Asher M, Min Lai S, Burton D, Manna B. The reliability and concurrent validity of the Scoliosis Research Society-22 patient questionnaire for idiopathic scoliosis. Spine 2003;28:63–9.

[42] Bridwell KH, Cats-Baril W, Harrast J, et al. The validity of the SRS-22 instrument in an adult spinal deformity population compared

with the Oswestry and SF-12: a study of response distribution, concurrent validity, internal consistency, and reliability. Spine 2005;30:455–61.

[43] Bridwell KH, Berven S, Glassman S, et al. Is the SRS-22 instrument responsive to change in adult scoliosis patients having primary spinal deformity surgery? Spine 2007;32:2220–5.

[44] Lai SM, Asher M, Burton D. Estimating SRS-22 quality of life measures with SF-36: Application in idiopathic scoliosis. Spine 2006;31:473–8.

[45] Edelen MO, Reeve BB. Applying item response theory (IRT) modeling to questionnaire development, evaluation, and refinement. Qual Life Res 2007;16(Suppl 1):5–18.